



Spectrometer Solenoid Overview

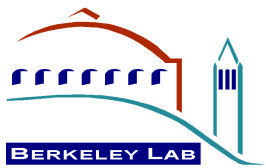
Past & Present

Spectrometer Solenoid Workshop

May 10, 2011

Steve Virostek

Lawrence Berkeley National Lab



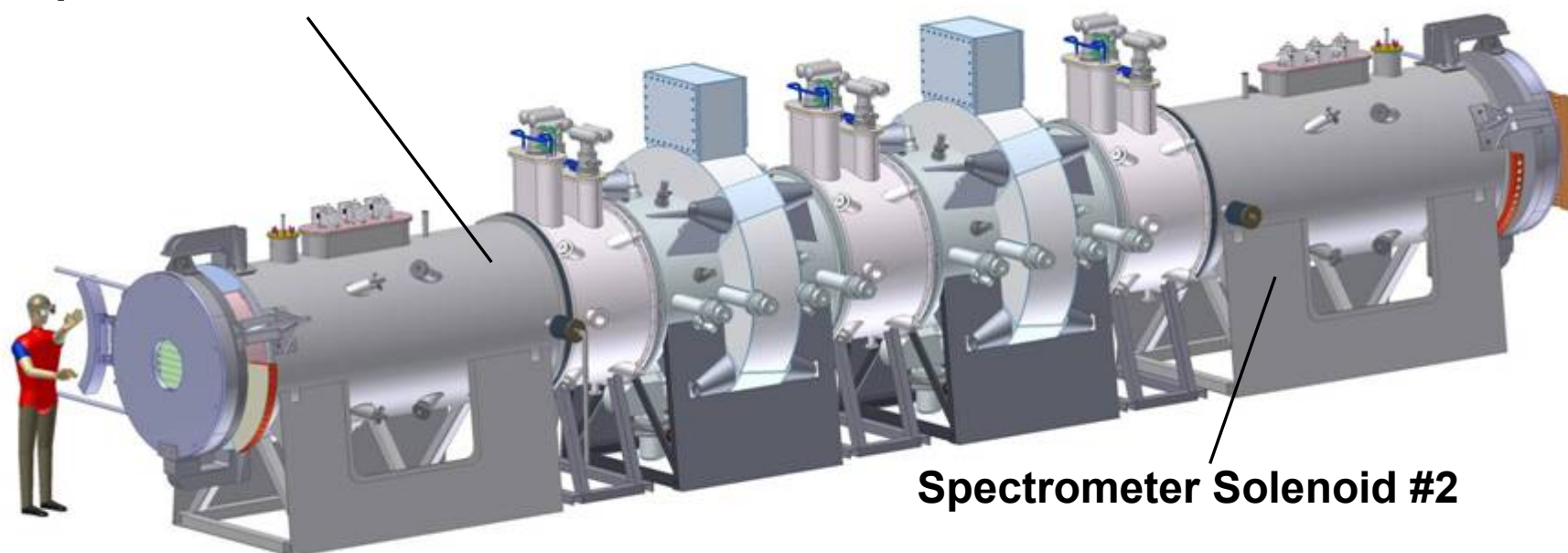
Topics



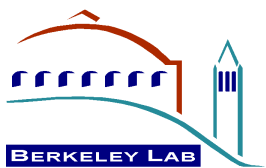
- Overview of the Spectrometer Solenoids
- Key magnet requirements
- Magnet 1 and 2 histories
- Current status and progress

MICE Cooling Channel Layout

Spectrometer Solenoid #1



Spectrometer Solenoid #2



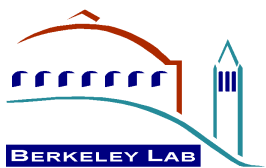
Spectrometer Solenoid Overview



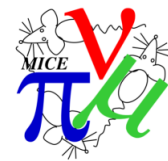
Key magnet requirements:

- Each of the five coils must be trained to 275 amps
- The cryocoolers must maintain the LHe in the cold mass (no boil-off)

Not yet achieved for either magnet

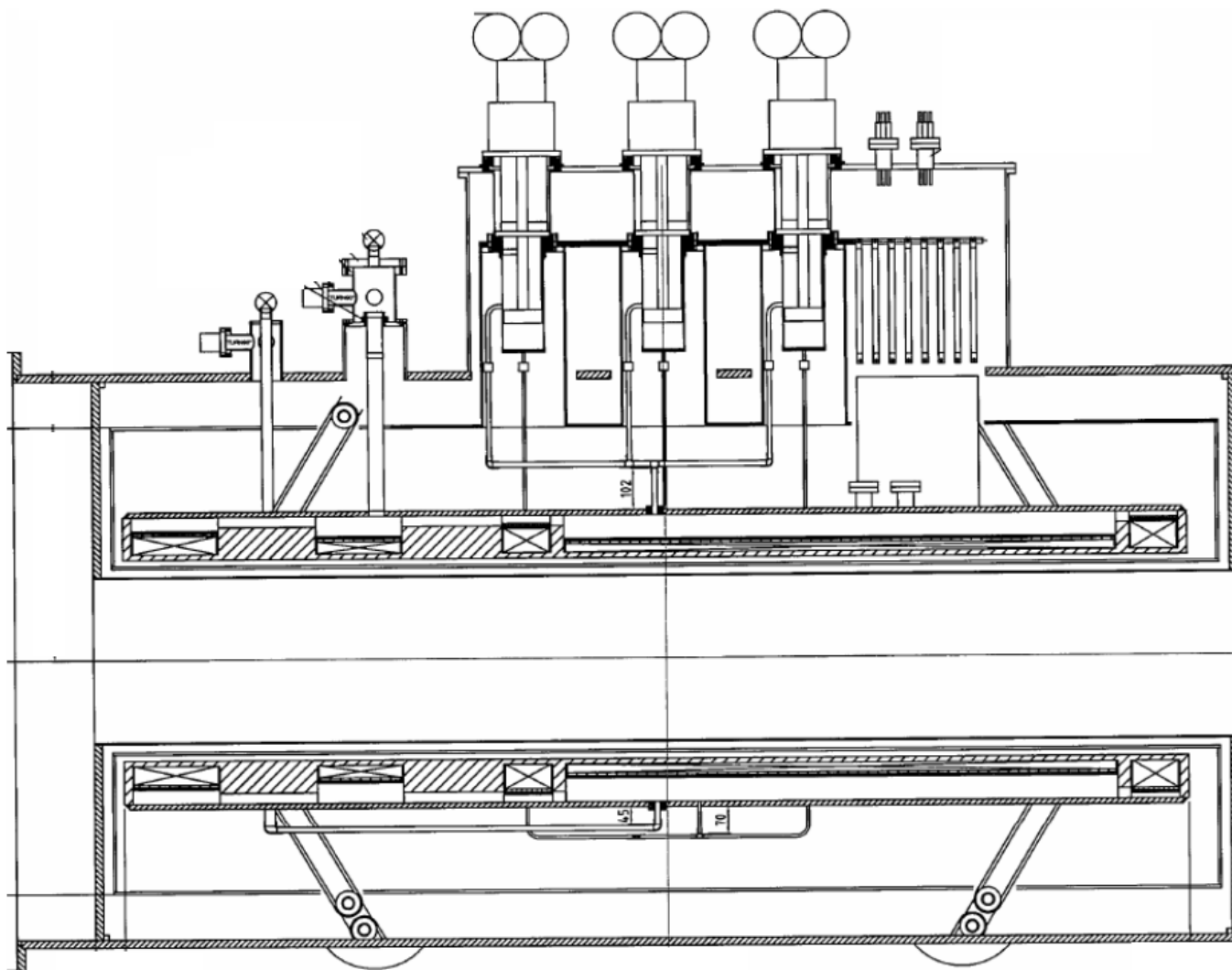


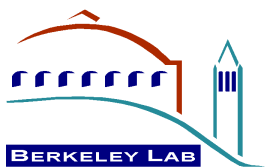
Magnet 1 History



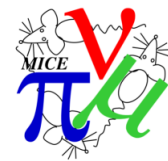
- Magnet 1 was built per the specifications of the original Wang NMR design report dated 9/6/06
- The cooling circuit consisted of small diameter tubes that fed recondensed LHe to the bottom of the cold mass and directed helium vapor from the top of the cold mass to the cryocooler recondenser cans
- Upon cooldown, the cryocoolers were not recondensing helium due to the liquid and vapor return lines being blocked by frozen
- While cold, the magnet was trained with all five coils running in series to a peak current of 196 amps was reached
- The training was discontinued when the available LHe ran out
- Magnet 1 was disassembled in order to allow modification of the recondensing circuit

Magnet 1 Cross Section



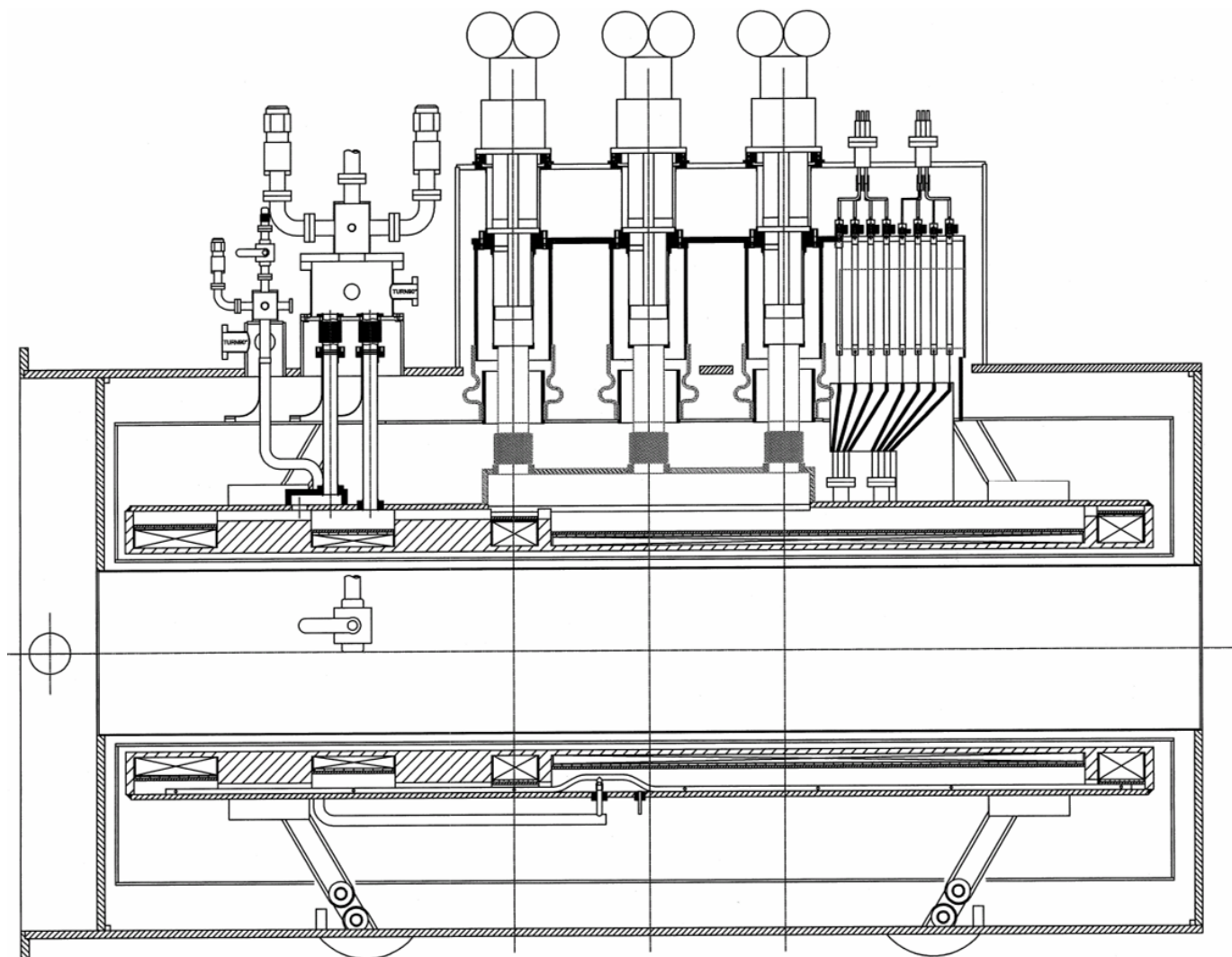


Magnet 2A History

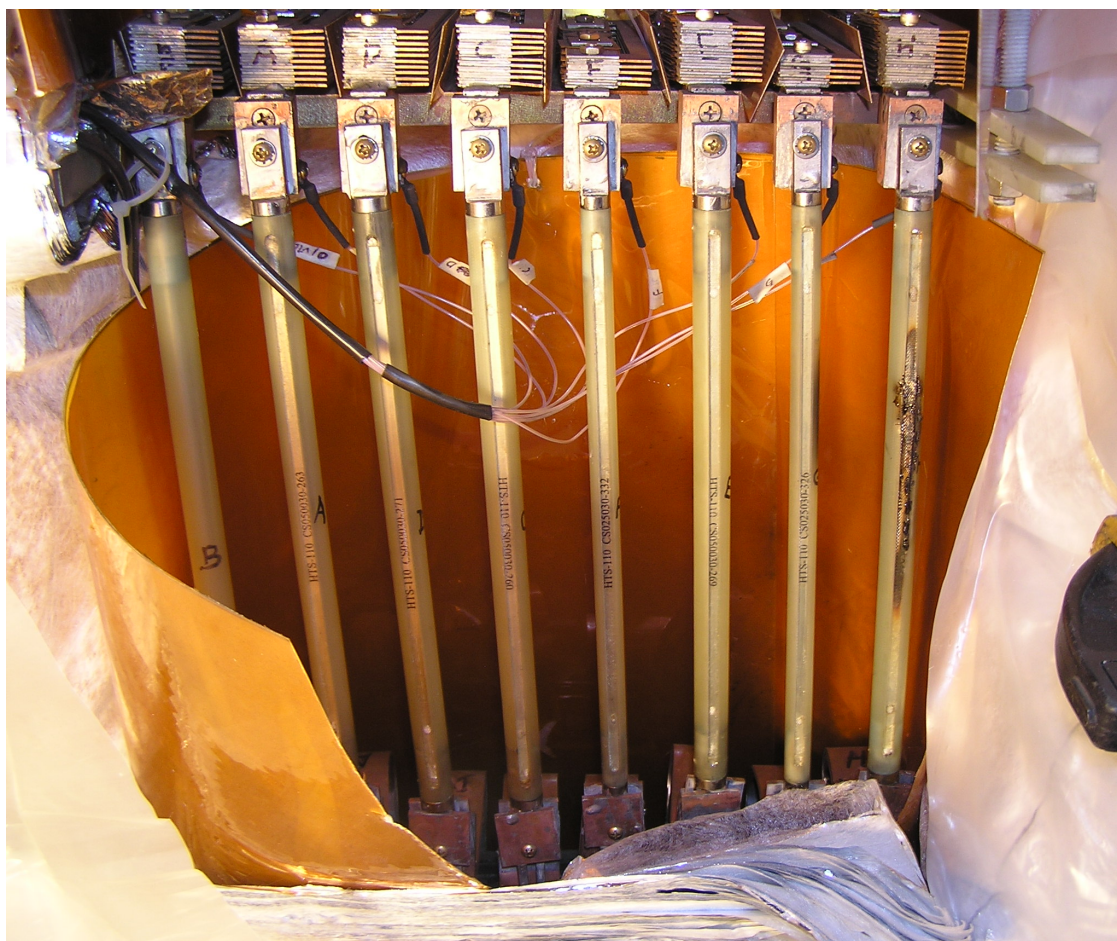


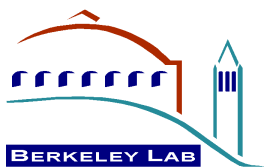
- The second magnet was assembled with a series of design changes
 - replacement of the cooling circuit with large diameter tubes connecting the condensing cans directly to the top of the cold mass
 - addition of an LN reservoir connected to the shield
 - replacement of the thin, flexible copper straps that connected the shield to the 1st stage copper plate with thicker 1100 aluminum straps
- Upon cooldown, the cryocoolers appeared to be recondensing helium, but the magnet did not reach an equilibrium with no LHe boil-off
- The training of the magnet commenced, and a current of 238 amps was reached at which point an open circuit was detected
- After warm-up, the magnet tower was opened, and a burned out HTS lead was discovered; the failure was caused by inadequate cooling of the HTS lead upper ends at their connection to the 1st stage Cu plate

Magnet 2A Cross Section



Burned Out HTS Lead



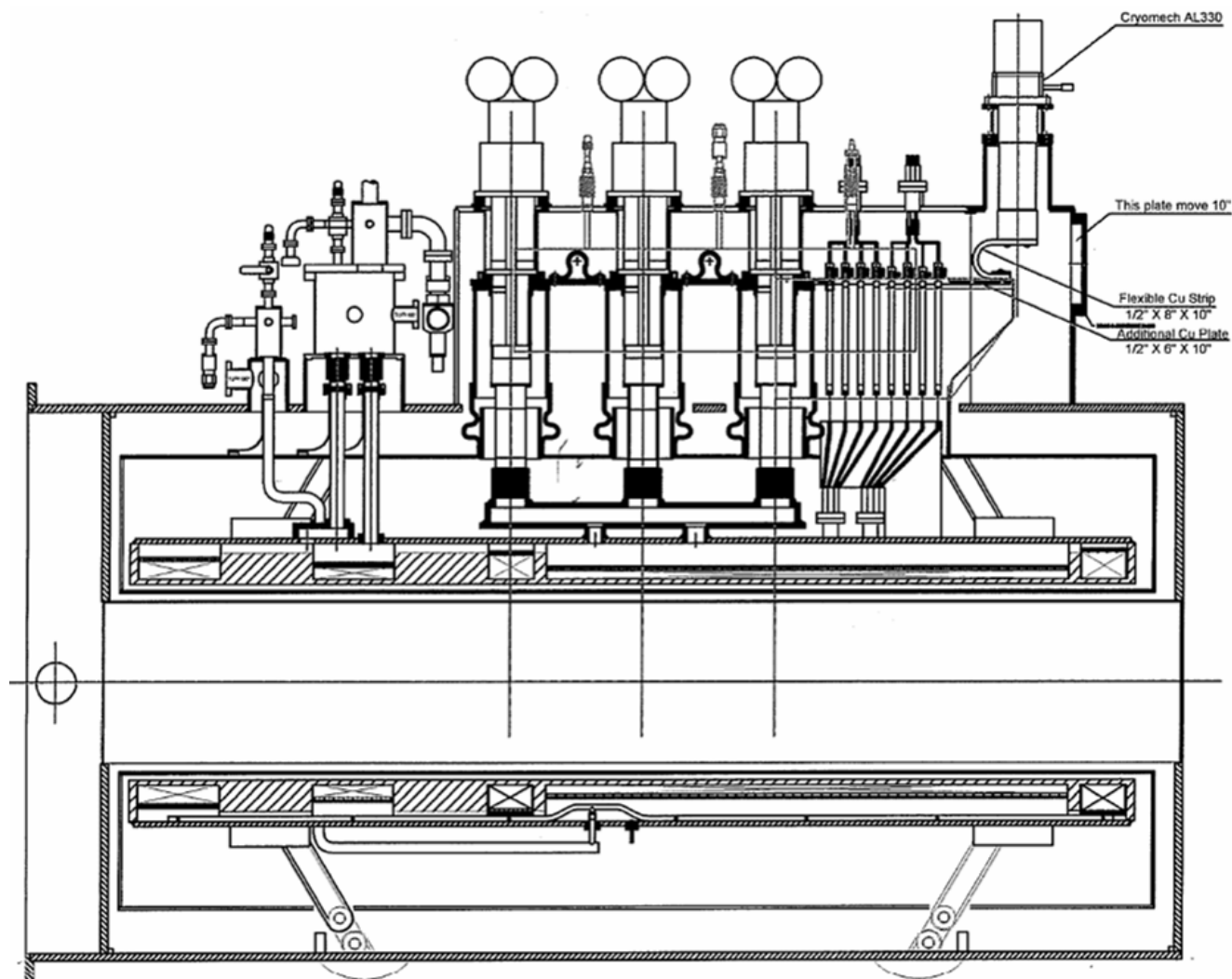


Magnet 2B History

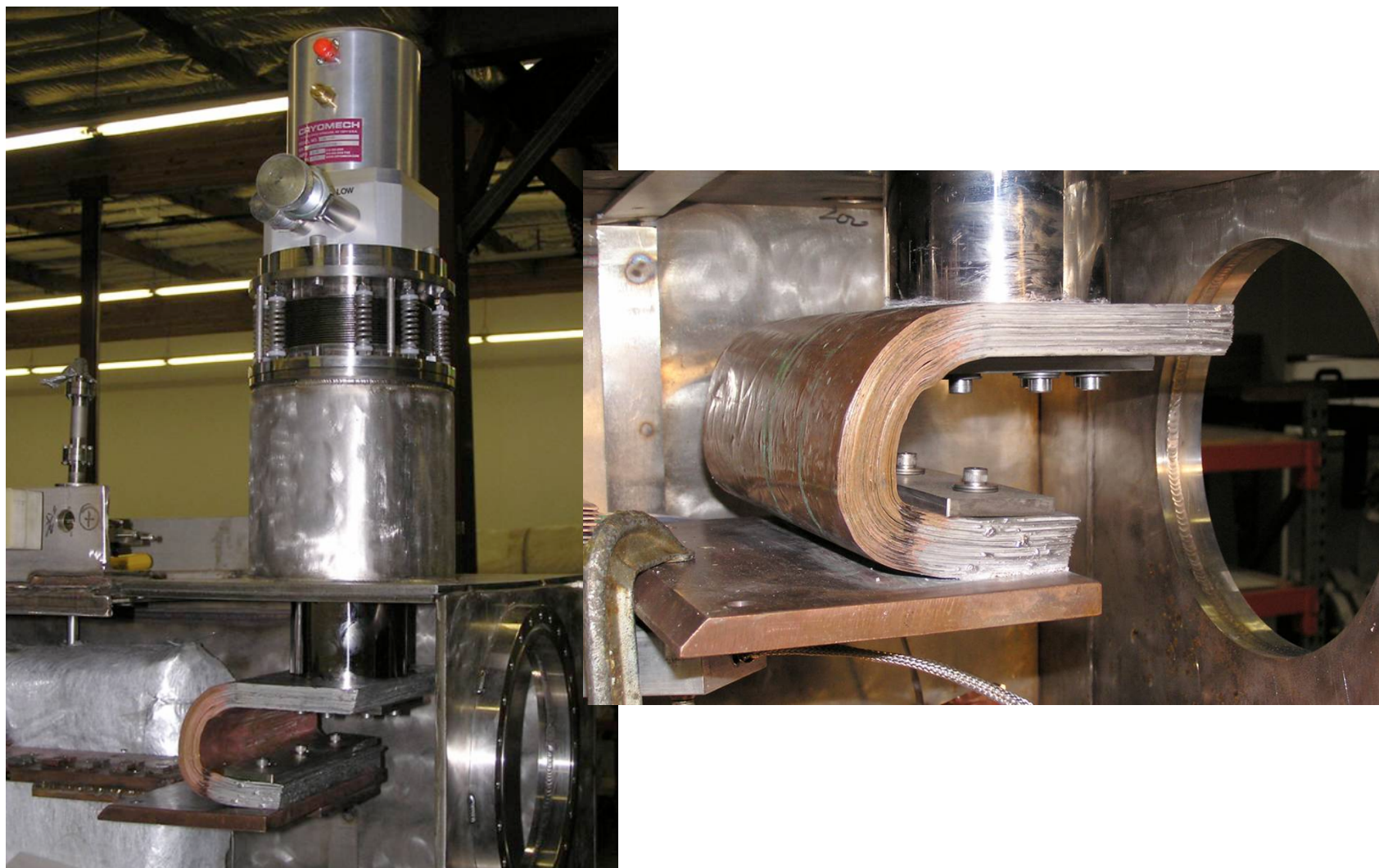


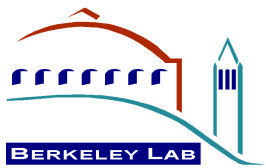
- A review committee was convened by MICE management in 11/09 in order to assess the magnet design and to recommend modifications
- Per the committee, a single-stage cooler was added to increase cooling at the HTS lead upper ends and to help reduce the shield temperature
- With the HTS lead issue solved, Magnet 2B was trained in series to 258 amps when a coil lead was again found to contain an open circuit
- The failure was traced to the M2 coil close to the He/vacuum feedthru
- Training on the Center, E1 and E2 coils in series continued and reached a current of 270 amps
- Also noted was the fact that the three 2-stage coolers plus the single-stage cooler could not maintain a closed LHe system

Magnet 2B Cross Section



Added Single Stage Cooler





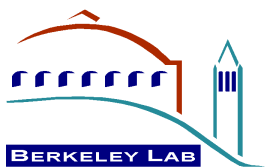
Current Magnet Status



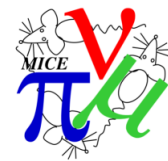
- After warm-up of Magnet 2, the cold mass was removed from the vacuum vessel and opened
- The failed lead was located just inside the cold mass feedthrough
- Analysis of the failure indicated that the conductor adjacent to the feedthru will require the addition of extra copper to stabilize it against movement and to enhance conductive cooling (M. Green analysis)
- This improvement of the leads was carried out on Magnet 2B during the repair of the failed lead
- The internal quench resistors in Magnet 2B were found to be damaged due to overheating
- Magnet 1 remains disassembled and will require opening of the cold mass and other proposed modifications

Magnet 2B Cold Lead Repair





Latest Magnet Progress



- A PO change order was issued to Wang NMR to complete the layout and detailed design of the modified magnet mechanical design
- Design modifications are being carried out by Wang NMR (specified by LBNL) and are nearing completion
- The 5+1 cooler layout has been completed
- LBNL is maintaining an as-built 3D CAD model of the magnets
- Both radiation shields will be remade from scratch using 6.35 mm thick 1100 series aluminum (material has been received at Wang NMR)
- The cold mass vent lines are being enlarged and radiation light baffles are being added
- The magnet instrumentation plan has been updated and the instrumentation feedthrough layout updated